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INTERNATIONAL COUNCIL FOR
THE EXPLORATION OF THE SEA.

C.M.1971/H:4
Pelagic Fish (Northern) Committee

REPORT OF THE WORKING GROUP ON NORTH SEA YOUNG HERRING SURVEYS.

I. Introduction and terms of reference

At the 1970 Council meeting it was recommended (C.Res.1970/2:10) that "The Working Group on North Sea Young Herring Surveys" should meet from 19 - 21 April 1971.
The meeting was held at Ymuiden from 19 - 21 April 1971 with the following participants:

Mr. A.F. Lisenko	- U.S.S.R.
Mr. O.J. Østvedt	- Norway
Mr. K. Popp. Madsen	- Danmark
Mr. K.H. Postuma (Chairman)	- Netherlands
Mr. A. Robles Pineda	- Netherlands
Mr. A. Saville	- Scotland
Mr. D. Schnack	- Germany
Dr. K. Schubert	- Germany
Dr. A. Schumacher	- Germany
Mr. J.R. Wood	- England
Mr. J.J. Zijlstra	- Netherlands

Part of the results of the 1965-1970 surveys were reported on a yearly basis to the Pelagic Fish Northern Committee and were published from 1968 onwards in Annales Biologiques.
During its first session the Group decided that the meeting should have the following objectives:

1. To study the relation between the data on the numbers of herring caught per one hour's trawling during the 1965-1970 surveys, as an index of abundance of young herring in the North Sea, and the subsequent recruitment to the autumn spawning populations in the North Sea.
2. To investigate changes that may have occurred in the distribution of young herring in the North Sea in the different survey-years and their relation to changes in the composition of the young herring stock.
3. To study the results of the accoustic surveys made during the 1971 young herring survey as alternative method of estimating the abundance of young herring in the North Sea.

It was agreed that, on the basis of the results of these investigations, the group would decide whether the young herring surveys should be continued. If the surveys were to be continued recommendation should be made concerning changes in the timing, in the methods applied, and the procedures to be followed.

II. Results

Section I - Abundance estimates of Young Herring compared with Adult Herring recruitment in the North Sea.

Abundance estimates of the year-classes encountered during the surveys were obtained by averaging all hauls made in each statistical

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square and than averaging the means over all the squares fished. In this way estimates of year-class strength were obtained for the yearclasses 1958-1959, (1962) and 1963-1969 at an age of the fish of 1,5 year approximately. The 1962 estimate was based on very few hauls. Estimates for the 1957 and 1960 year-classes were derived from a comparison with the 1958 and 1959 fish at different ages, as explained in Coop. Res. Reprt. Series 14. Annual estimates of recruit strength were available for the Northern, Central and Southern North Sea spawning grounds up to the 1965 year-class (North Sea Herring Assessment Group Report).

New information on the 1966 and 1967 year-classes was added (see table 1). For all three stocks it has become progressively more difficult in recent years, to get reliable estimates of year-class strength of recruits. This is partly because of a severe decline in the fisheries from which the estimates are obtained and partly because of suspected or known efficiency changes in these fisheries.

As a first approach the Young Herring Surveys estimates were compared with indices of recruitment to the adult stocks in the Northern, Central and Southern North Sea. These are shown in fig. 1 a-b-c. With the exception of the Central North Sea, no relationship was apparent. A relationship, however, could hardly be expected, as the estimates from the surveys are indicative of the total year-class strength in the North Sea autumn spawning stocks rather than to any of these stocks in particular. In these circumstances it is necessary either to intergrate the recruitment estimates to the adult stocks or to distinguish between the immatures of the three individual stocks sampled during these surveys.

To achieve an estimate of total recruitment to the North Sea autumn spawning-stocks it is necessary to have estimates of relative stock strength. These were found in the estimates of annual larval production from each of the three stocks, published up to 1969 in the Report of the North Sea Herring Assessment Group to which additional data for the year 1970 was added. It proved necessary to estimate total larval production in one year, both in the Central and Northern North Sea and to make some assumptions regarding the relationship between production in part of the area and total production throughout the entire area for several years in the Central North Sea.

Data used and modifications applied are given in table 2.

From these estimates of total larval production in each year estimates of the proportion produced by 3-year old spawners were derived from the percentage age-composition of the spawning stocks. An additional correction had to be made for the different fecundity of recruits and older fish by taking the fecundity of recruits as half that of all older fish. Estimates of recruit strength derived in this way are given in table 2, together with estimates of total recruit strength obtained by the summation of those from the individual stocks.

Figure 2 a shows the relationship between year-class-strength, as astimated by the Young Herring Surveys and total recruitment to the North Sea spawning stocks. With exception of the estimate of the 1962 year-class, which was based on very few observations in the surveys, a reasonable good relationship appears.

In figure 2 b the same recruitment data (spawning stocks) are related to estimates of immature year-class-strength derived from the Blåden fishery (figure 3 of the North Sea Herring Assessment Group Report).

The relationship between these two estimates is certainly less convincing. From the Young Herring Surveys estimates of year-class-strength are also available for II group fish from some year-classes (2,5 years old). The I and II group indices of a year-class were found to be fairly well related. A comparison of the indices of recruit strength of II group fish with estimates of overall recruitment strength to the adult stocks is shown in fig. 3 and suggests a relationship.
An attempt was made to delimit the distribution of the Downs and Central and Northern Sea immatures. On the basis of length differences (see section2) with only five year-classes available there was no apparent relationship between the estimates of immature and recruit abundance for either the Downs or the Central and Northern North Sea stocks.
However, in view of the limited time and data available the method was not thoroughly explored.

Table 1 - Recruitment indices to North Sea stocks.

Year-class	North-West (Saville) (tenth of a cran per landing)	Central (Zijlstra + Postuma) (hundreds per day fishing)	Downs (Burd) (hundreds per shot)	Young Herring Surveys estimates
1951	42	77	218	---
1952	71	235	109	---
1953	50	43	321	---
1954	73	63	243	---
1955	17	148	95	---
1956	194	373	180	---
1957	42	20	80	910
1958	22	126	366	1230
1959	14	7	30	337
1960	170	256	180	3410
1961	70	74	168	---
1962	52	87	30	650 (?)
1963	180	259 x')	100	2797
1964	51	27 x	68	805
1965	61	38 x	10	552
1966	97	65 x	330 *)	273
1967	128	70 x	55 *)	455
1968	---	---	---	487
1969	---	---	---	1416

x') Before 1963 year-class numbers calculated by season break-down in 3-days periods (restricted season), there after by taking total catch (numbers) divided by total effort. In post 1962 data an increase in efficiency raise of the effort has been corrected, multiplying by $\frac{1}{1.3}$.

*) Dutch catch per effort, converted to English-units using the relationship between Dutch and English c/f estimates for the year-classes 1957-1962 and 1965.

Table 2 - Overall recruitment estimates North Sea Herring based on Larval production.

Year	Year-class	Northern North Sea			Central North Sea			Downs			Total
		a	b	c	a	b	c	a	b	c	c
1960	1957	1080	24	147	272[2)]	65	131	16	50	5	183
1961	1958	5320	5	136	172[2)]	32	33	56	72	32	201
1962	1959	1120	17	104	132[2)]	3	2	29	22	4	110
1963	1960	1020	75	612	100[3)]	81	68	7	90	6	686
1964	1961	1800	40	450	63[2)]	32	12	6	47	2	464
1965	1962	2290	39	555	490[2)]	59	205	5	19	1	761
1966	1963	690	54	255	142[2)]	69	75	30[3)]	63	14	344
1967	1964	440	13	31	275	18	27	40	65	19	77
1968	1965	162	49	53	28	32	5	6	48	2	60
1969	1966	212	77	133	11	16	5	87	94	77	215
1970	1967	273	81	186	273	64	72	95	46	28	286

a = Larval abundance (x 10^9).
b = % 3-year old spawners.
c = estimated abundance of 3-year old spawners.
') estimated.
2) Only Dogger larvae available, larval production for total area estimated 2 x Dogger Larvae.
3) No data available, estimated from proceeding and succeeding years.

Section II - Distribution of the Young Herring in the North Sea in the years 1965 - 1970.

The distribution of 1-year old herring in the various surveys together with the mean length, V.S. and K_2 data available was investigated.
The centres of abundance of each year-class at 2 years of age were compared in the following surveys.
The 1963 year-class was not sampled in sufficient squares to justify drawing any conclusions regarding its overall distribution. With subsequent year-classes, however, considerable differences were apparent in the main centres of distribution and it was also possible to see considerable differences in the mean lengths of herring which were distributed in various parts of the North Sea.
With the year-classes 1964, 1965, 1966 and 1967 sharp boundaries were apparent between areas in which the 1-year old herring had low mean lengths (i.e. below either 15 or 16 cms) and areas in which the mean lengths were considerable higher (see charts in fig. 4, 5, 6, 7).
Herring of the 1968 year-class with mean lengths below 16 cms were generally distributed throughout the area surveyed although they were much more abundant in the south-east part of the area.

Because of these differences in mean lengths the abundance in each year-class of those herring which had low mean lengths and those with high mean lengths was examined. For those year-classes which had already recruited to the adult stocks (1.e. 1964-67 year-classes) it was first ascertained that the length differences on which the separation was based in the 1-year old herring, were closely related to the L_1 differences between southern North Sea and northern and central North Sea spawners. In some instances V.S. and in particular K_2 values were also usefull in supporting these separations.

Table 3 - Division of catches based on mean length differences.

Year-class	low mean length herring			high mean length herring		
	no. of herring	squares	mean no. per hour	no. of herring	squares	mean no. per hour
1964	2.316	14	171	23.297	22	2.059
1965	365	7	52	14.051	48	293
1966	1.307	13	101	14.891	45	331
1967	287	4	57	11.245	61	187
1968	27.434	24	1.143	8.252	41	201
1969 (data incomplete)	88.579	72	1.230	56.626	29	1.953

Section III - Acoustic Methods.

Two attemps to apply acoustic methods were made during the survey of 1971. The Norwegian research vessel "G.O.Sars" did an echo-integrator survey in February and the Dutch "Tridens" measured echo-abundances during trawl hauls.

1. Integrator-survey.

The survey covered the main part of the North Sea with special emphasis in the young herring areas south and east of the Dogger. A Simrad Scientific Sounder (E.K. 38) connected with two integrators as operated throughout the survey. One integrator was set at 1-125 m. and the other at 0-250 m. or, over the Norwegian Deep at 0-500 meter (Tranducer 5^0 x 5.50).
The integrator values were recorded per 5 nautical miles and average values were calculated for each statistical square. A preliminary inspection of the results brought forth the following points:

a. Within statistical squares differences were observed between day and night recordings. Over the main part of the North Sea surveyed a ratio of 1 : 5 was found, while smaller areas south-east and west of the Dogger only produced small differences between day and night. In the latter case echo-recordings at night indicated pelagic occurences right to the bottom of the ship and is reasonable to assume, that an appreciable amount of targets were present above the transducer depth and consequently failed to be recorded by the integrator. The existence of a day and night differential indicates the need for introducing a correction factor, when day and night recordings have to be combined.

b. Direct identification of the echotraces proved to be very difficult and sampling the fish traces was done as frequently as possible, using a bottomtrawl in day time. This excludes identification of fish situated more than 3 - 5 meters above the bottom and in future a more appropriate sampling gear is desirable.
A tentative allocation of the integrator values was done based upon the catch composition in numbers, flatfish excluded.

c. Comparison between integrator values and the average number of herring caught per square by all participants in the young herring surveys failed to produce a significant correlation. This is probably due to the fact, that in most cases herring only constituted a minor component of the catch.
A correlation between integrator values and total fish catches could not be undertaken because the appropriate data were not available.

2. Echo-abundance during hauls.

Echotraces within two fathoms from the bottom were measured during each trawl haul and recorded in units of mm2 per nautical mile.
Significant correlations were found between echo-abundance and the catch in that haul:

Predominant species	r = 0,76
All species	r = 0,70
Herring	r = 0,65

In the case of the herring the significance of the correlation depended on one outstanding large catch and it was evident that over the main part of the North Sea, where herring abundance was moderate to low, echotraces did not offer a representative picture of the herring distribution.

III. Conclusions and Recommendations.

A. Conclusions.

1. Estimates of the abundance of immature herring, derived from the International Young Herring Surveys both as I and II group fish, show a reasonably good relationship to the overall recruitment to the total North Sea autumn spawning population.
It should be noted, however, that the estimate of recruitment to the adult spawning stocks used in the report is dependent on annual estimates of larval production in each of the stocks and at present no other method is available for obtaining the relative sizes of these stocks. It is therefore necessary to continue and indeed intensify the International Herring Larval Surveys if the material collected on the Young Herring Surveys is to be fully evaluated.

2. The treatment of the data, possible in the time available to the group, did not allow estimates of abundance of recruits to the individual spawning stocks to be made with sufficient precision to evaluate their usefullness as a tool in forcasting recruitment prospects for the stocks. This problem requires further consideration.

3. On the basis of the separation of herring with a low mean length and with a high mean length it is clear that for spawning populations with a low L_1 both the 1968 and 1969 year-classes are relatively very good, while for spawning populations with a relatively high L_1 the 1964 and 1969 year-classes are the strongest.
   The remainder of the year-classes are all of fairly similair low strength. In each of the 1964 - 1967 year-classes the spawning populations with a low L_1 contributed less than 10% of the herring sampled.

4. When the distribution of each year-class at both 1 and 2 years of age is compared it appears that while there was a marked shift in a westerly direction by both the 1963 and 1965 year-class fish during this period there was by contrast a S.E. movement by herring of the 1967 year-class. No obvious changes in the distributions of the other year-classes could be discerned.

5. In general the herring which had low mean lengths and which were ascribed to spawning groups with a low L_1 were distributed mainly in the S.E. part of the central North Sea at 1 year of age. Herring with a high mean length tended to be distributed more in the north and west.

B. Recommendations.

In respect of the discussions and the conclusions reached the group decided to draw up the following recommendations:

1. The Young Herring Surveys in the North should be continued in future.

2. The survey pattern of the individual ships should be reconsidered for future surveys and this problem should be discussed during the forthcoming I.C.E.S.-meeting in Helsinki in October.

3. The overall survey period of all ships in future surveys should be as short as possible and in any event should be confined to February.

4. Serious consideration should be given to the possibility of carrying out a discriminant function analysis on the material collected during the 1965 - 1971 surveys; an initial appraisal of the data available for this purpose should be made.

5. Acoustic surveys should be continued in future surveys with special reference to the differences in the day and night recordings in the same areas. If ships time is available two echosurveys should be carried out, one during the February survey and another during two weeks in autumn.

6. The recordings of data on catch composition per species and the weight of each species in future surveys should be standardised.

7. During all hauls echo-recordings should be made separately for echotraces from the bottom to 4 meter above the bottom and the remainder of the water column.

Figure 1

Relation between recruitment of three year old herring to the fisheries and the abundance estimate of one year old herring in the young herring surveys.

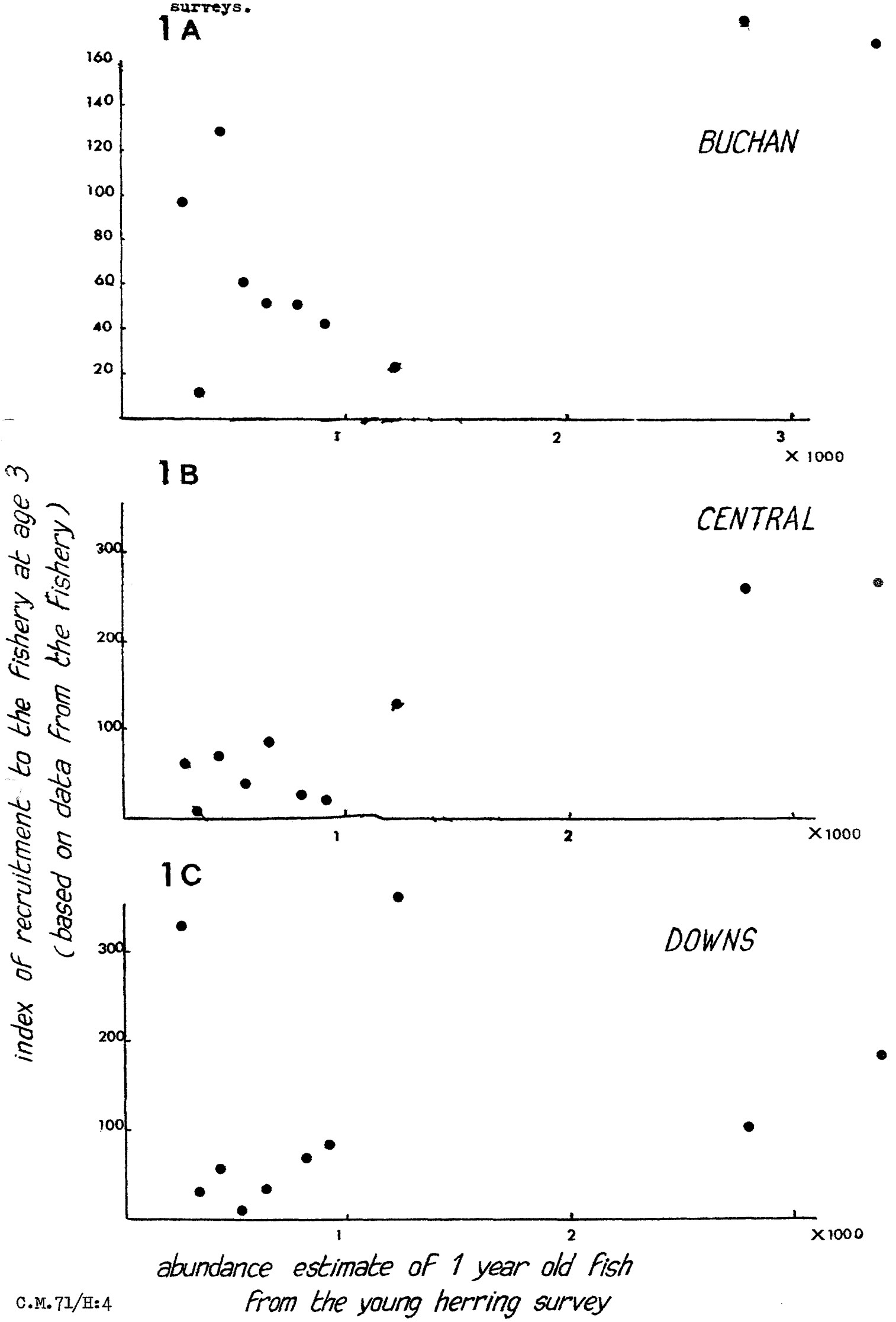

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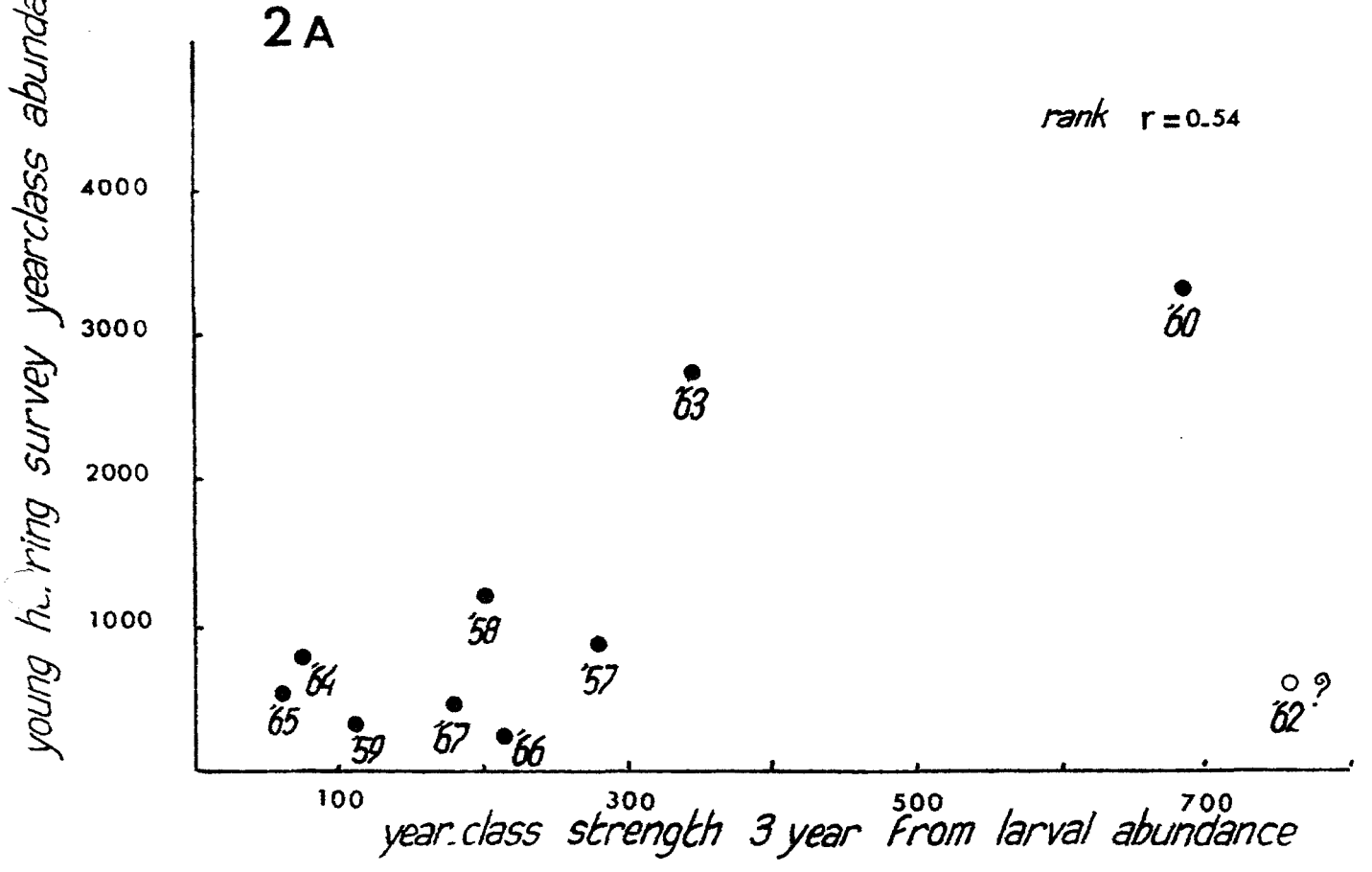
Figure 2

Relation between recruitment strength, at three years of age, as measured by the larval abundance and the year-class strength as measured by the abundance of one year old fish in the Bløden fishery and the young herring surveys.



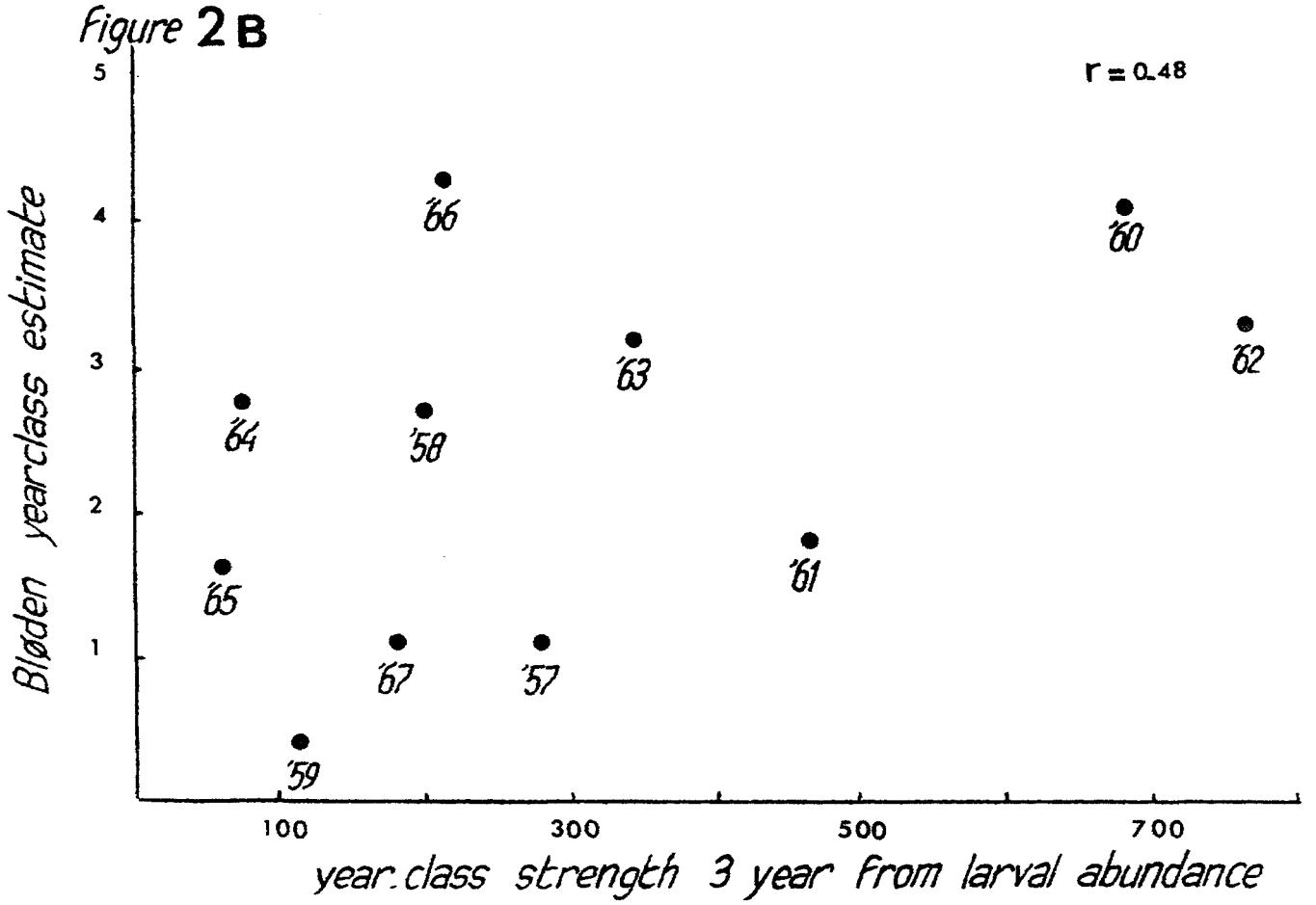


Figure 3

Relation between abundance estimates of two year old herring in the young herring surveys and the subsequent recruitment of three year old herring as measured by the larval abundance.

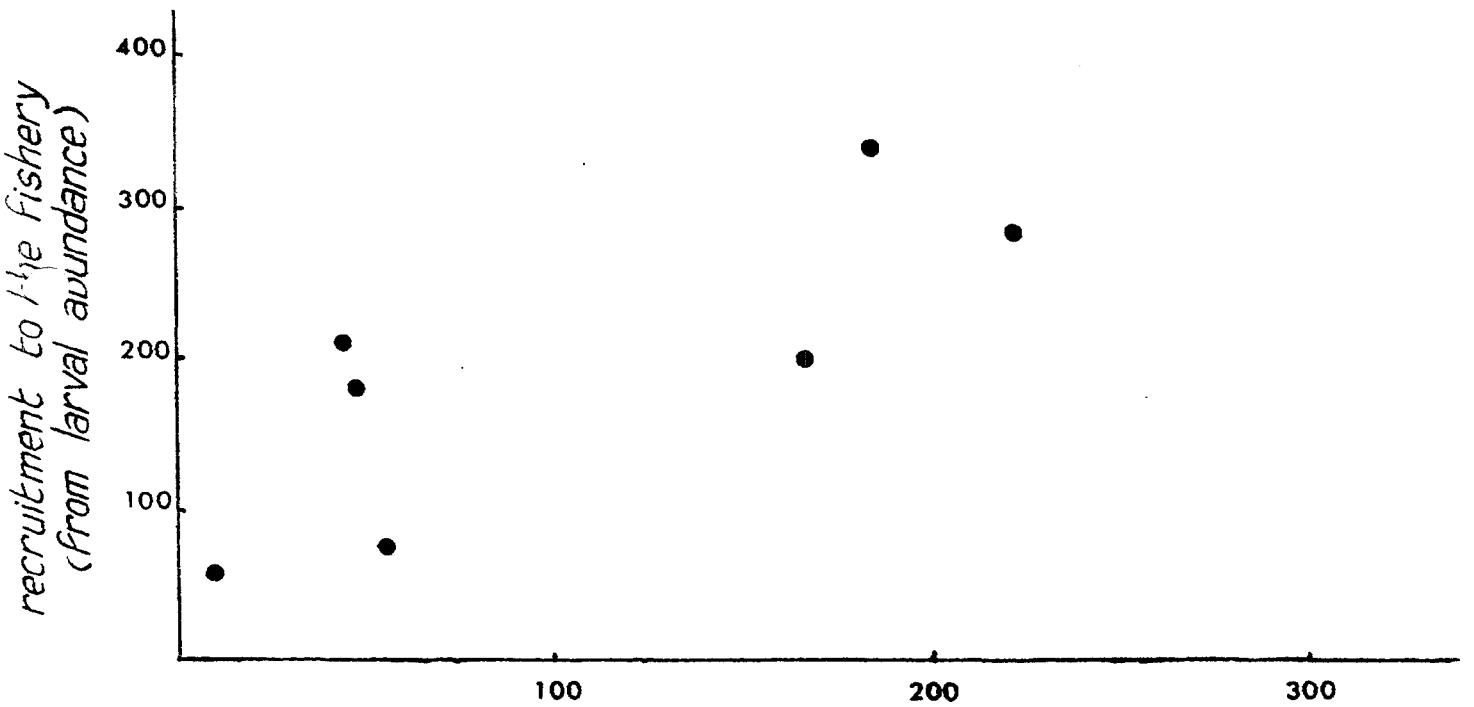


Fig. 4

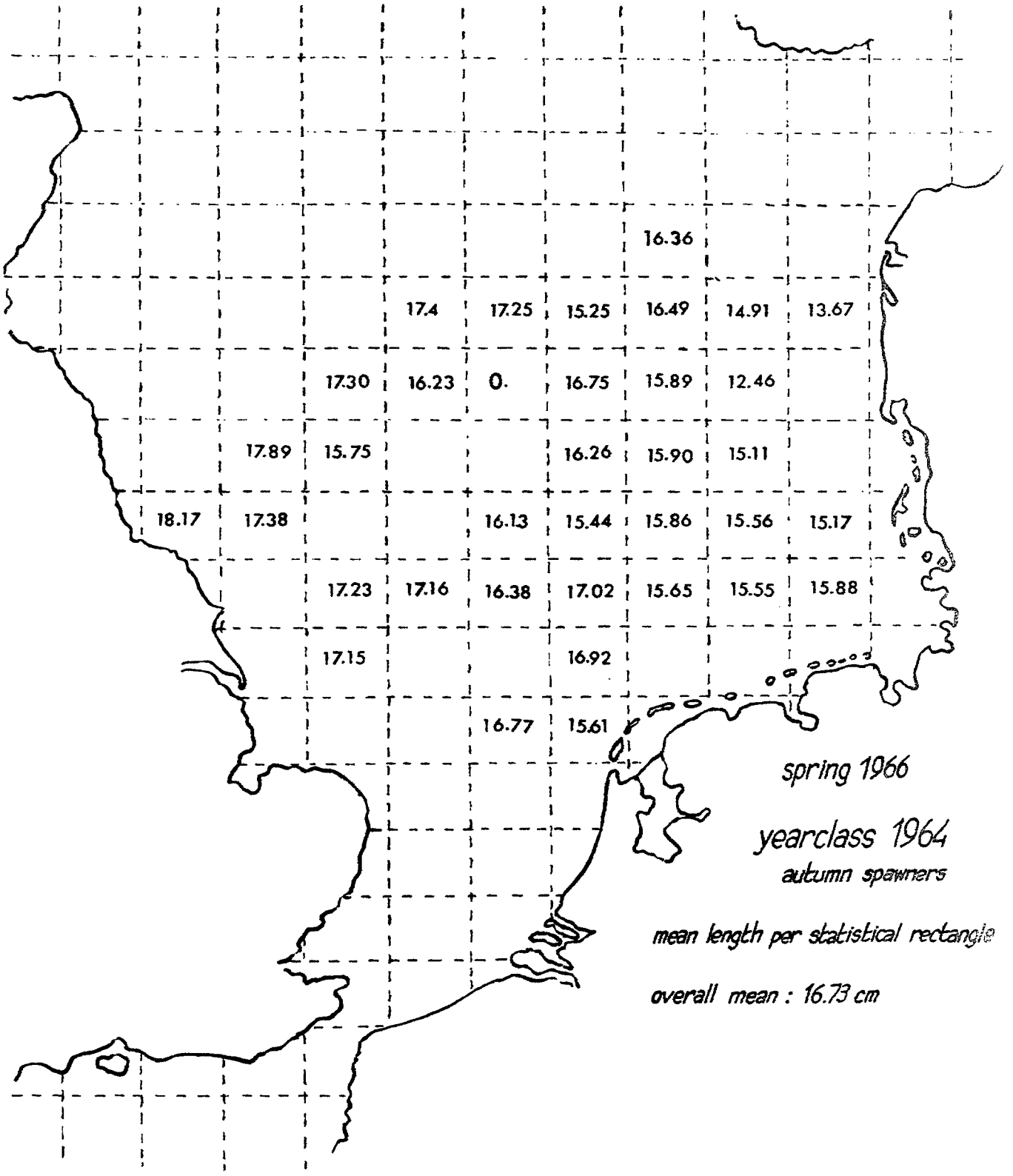


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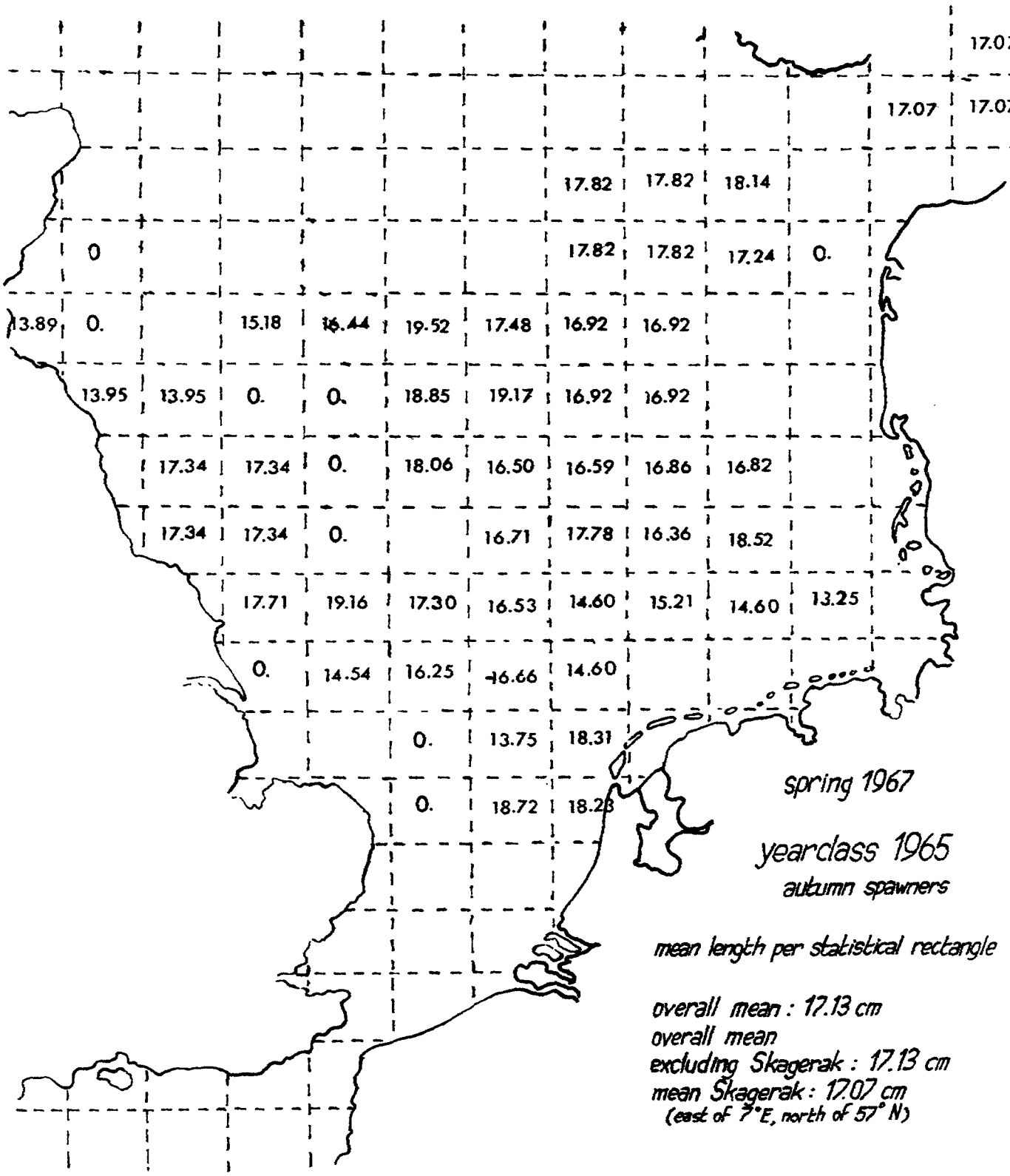
Fig. 5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13.75
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0.
18.72
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spring 1967
yearclass 1965
autumn spawners
mean length per statistical rectangle
overall mean : 17.13 cm
overall mean
excluding Skagerak : 17.13 cm
mean Skagerak : 17.07 cm
(east of 7°E, north of 57° N)

Fig. 6

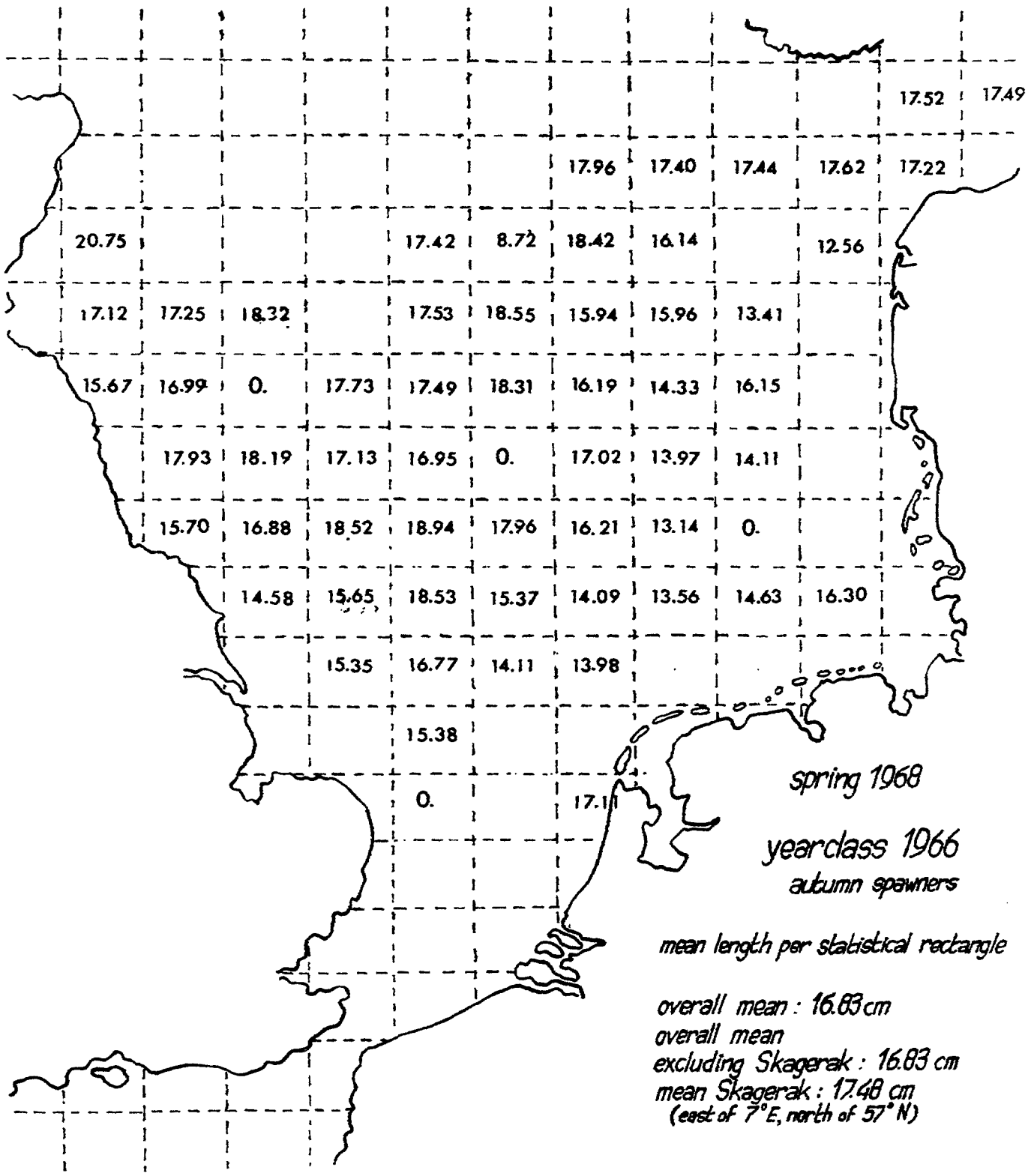

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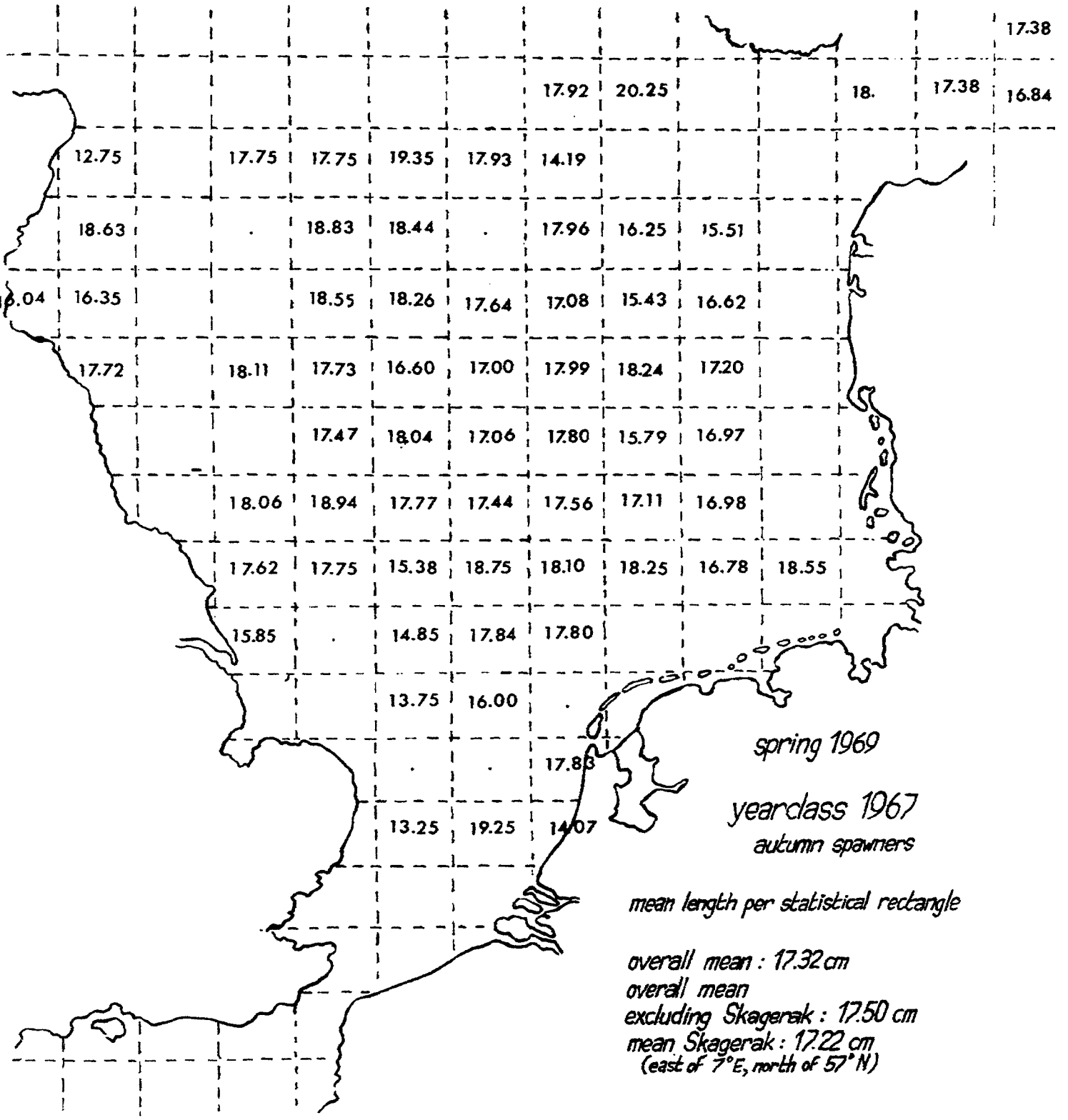
Fig. 7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13.75
16.00
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13.25
19.25
14.07
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(east of 7°E, north of 57°N)